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The World Bank

Report No: 24069

IMPLEMENTATION COMPLETION REPORT
(SCL-44660)

ON A

LOAN

IN THE AMOUNT OF US$5.0 MILLION

TO

THE REPUBLIC OF CHILE

FOR A

CL-MILLENNIUM SCIENCE INITIATIVE PROJECT

12/18/2002

Human and Social Development Group
Argentina, Chile and Uruguay Country Management Unit
Latin America & the Caribbean Regional Office

CURRENCY EQUIVALENTS

(Exchange Rate Effective April 29, 2002)

Currency Unit	=	Chilean Peso (CLP)
1000 CLP	=	US$ 1.529
US$ 1.0	=	653.94 CLP

FISCAL YEAR

July 1 June 30

ABBREVIATIONS AND ACRONYMS

CAS	Country Assistance Strategy
CONICYT	*Comisión Nacional de Investigación Científica y Tecnológica*
CFP	Competitive Fund Selection Process
ES	Executive Secretariat
GoC	Government of Chile
FONDAP	*Fondo Nacional de Desarrollo de Areas Prioritarias*
IBRD	International Bank for Reconstruction and Development
ICR	Implementation Completion Report
IMU	Implementation and Management Unit
LIL	Learning and Innovation Loan
M&E	Monitoring and Evaluation
MECESUP	*Proyecto de Mejoramiento de la Calidad de la Educación Superior*
MIDEPLAN	*Ministerio de Planificación y Cooperación*
MSI	Millennium Science Initiative
OECD	Organization for Economic Cooperation and Development
PAD	Project Appraisal Document
Ph.D	Doctor of Philosophy
PMR	Project Management Report
R&D	Research & Development
SI	Millennium Science Institute
SN	Millennium Science Nuclei
S&T	Science and Technology

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CHILE
CL-MILLENNIUM SCIENCE INITIATIVE (LIL)

CONTENTS

Project ID: P063386

Project Name: CL-MILLENNIUM SCIENCE INITIATIVE (LIL)

Team Leader: Lauritz B. Holm-Nielsen

TL Unit: LCSHE

ICR Type: Core ICR

Report Date: December 18, 2002

1. Project Data

Name:	CL-MILLENNIUM SCIENCE INITIATIVE (LIL)	*L/C/TF Number:*	SCL-44660
Country/Department:	CHILE	*Region:*	Latin America and Caribbean Region
Sector/subsector:	Central government administration (85%); Tertiary education (15%)		

KEY DATES

			Original	*Revised/Actual*
PCD:	01/13/1999	*Effective:*	09/23/1999	09/23/1999
Appraisal:	01/15/1999	*MTR:*	06/30/2000	03/24/2000
Approval:	04/30/1999	*Closing:*	03/31/2002	09/30/2002

Borrower/Implementing Agency: REPUBLIC OF CHILE/MINISTRY OF PLANNING

Other Partners:

STAFF	Current	At Appraisal
Vice President:	David De Ferranti	Shahid Javed Burki
Country Manager:	Axel van Trotsenburg	Myrna L. Alexander
Sector Manager:	Marito Garcia	Donald Winkler
Team Leader at ICR:	Lauritz B. Holm-Nielsen	Lauritz B. Holm-Nielsen
ICR Primary Author:	Shashi K. Shrivastava; Michael Crawford; Lauritz B. Holm-Nielsen	

2. Principal Performance Ratings

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HL=Highly Likely, L=Likely, UN=Unlikely, HUN=Highly Unlikely, HU=Highly Unsatisfactory, H=High,
SU=Substantial, M=Modest, N=Negligible)

Outcome:	HS
Sustainability:	HL
Institutional Development Impact:	SU
Bank Performance:	HS
Borrower Performance:	HS

	QAG (if available)	ICR
Quality at Entry:		HS
Project at Risk at Any Time:	No	

3. Assessment of Development Objective and Design, and of Quality at Entry

3.1 Original Objective:

As a learning and innovation loan, the central objective of this project was to learn to improve the sector of science and technology (S&T) in Chile, leading to successful follow-on activities.

Specifically, the project aimed to demonstrate improved performance in a highly selected segment of Chilean S&T system. The project intended to help revitalize the Chilean S&T system by supporting advanced training of human capital by world-class scientists engaged in cutting edge research. It sought to demonstrate the effectiveness of a transparent, merit-based allocation procedure for financial support and investigator autonomy, as a way to improve the quality and efficiency of scientific research and training. Improved performance was expected in the areas of (i) quality of the selection process, (iii) human resources training opportunities, (iv) international collaboration among researchers, (v) administrative efficiency, (vi) allocation of resources, and (vii) perception of S&T policy in Chile.

The project addressed Chile's long-term goal of revitalizing the national innovation system by increasing the country's capacity to produce, gain access to, and adapt scientific and technological knowledge - a factor that is of critical importance to sustainable economic and social development. The project was directly linked to the World Bank's Country Assistance Strategy (CAS) objective of upgrading Chile's human capital with a view towards improving the country's competitiveness in the international arena. Achieving this long term objective would be contingent upon continuation and expansion of the activities piloted under the LIL.

The idea for the Millennium Science Initiative (MSI) in Chile, in the form of a pilot project for the development of cutting edge scientific research through a competitive fund which adhered to high international standard, resulted from the recommendations of an International Conference on Science and Technology, held in Santiago in 1998. This MSI project was the first of a series of MSIs launched recently in several countries (Chile, Venezuela, Brazil, Mexico) with World Bank assistance.

The development objectives are clear and well targeted to Chile's current economic and social conditions, as well as its development ambitions.

3.2 Revised Objective:

There was no revision of the original objective.

3.3 Original Components:

The project consists of three components: (1) Management structure for the MSI; (2) Competitive fund for scientific excellence; and (3) Network for the promotion of scientific excellence.

Project Component 1- Management Structure : (total actual cost US$ 1.1 million or 114 percent of appraisal estimates). This component includes the: (i) Establishment and operations of a Board of Directors, Program Committee, and Implementation and Management Unit; (ii) Technical assistance for selection of Science Institutes and Science Nuclei; (iii) Development of a proposal to improve Chile's institutional framework for science and technology research and training; and (iv) Carrying out of studies to monitor and evaluate of the Project.

Project Component 2- Competitive Fund for Scientific Excellence: (total actual cost US$ 12.5 million or 104 percent of appraisal estimates). This component consists of the funding of research projects at 1-3 Science Institutes and 5-10 Science Nuclei. The grants would finance : (i) scientific research, (ii) expansion of doctoral and post-doctoral training programs and opportunities; and (iii) networking, outreach and special activities to promote scientific excellence. For a description of *Science Institutes (SI)* and Science Nuclei (SN) see Annex 2 in Project Appraisal Document (PAD), Report No. 19130-CH. The projects to be financed by

the Fund would be carried out at SIs and SNs by Chilean scientists of international stature performing synergistic work in one or more cutting edge fields who are able to compete scientifically in the highest level in international arena. Expenditures to be financed by the Fund comprise: cutting-edge scientific equipment, infrastructure rehabilitation (including laboratories), fellowships for doctoral and post-doctoral students, and publications.

Project Component 3: Network for the Promotion of Scientific Excellence: (total actual cost US$ 1.3 million or 88 percent of appraisal estimates). Carrying out of networking for scientific collaboration and outreach activities to disseminate the benefits of quality research to potential collaborators and beneficiaries such as students, fellow researchers and/or partners from business and industry. The activities include: (i) visits to establish formal and informal connections to international science and technology institutions; (ii) design and delivery of advanced courses, (iii) exchange program for researchers, and graduate and post graduate courses; and (iv) dissemination workshops.

The project components are well designed with the appropriate allocation of resources given the parameters in which the overall investment of US$ 15 million over 2.5 years was defined.

3.4 Revised Components:

There was only one amendment to the Loan Agreement on July 2, 2001 thereby the Networking and Outreach (Component 3) was merged with the Competitive Fund for Scientific Excellence (Component 2) in order to simplify project administration. The change was minor and did not affect either the objectives of the project or the implementation of project activities.

3.5 Quality at Entry:

The overall quality at entry for the project is rated as highly satisfactory because: (i) the main sector issues were identified correctly; (ii) significant stakeholder consultation was undertaken during identification and preparation; (iii) the project was designed as an instrument that would help overcome obstacles and positively influence key factors in the sector; (iv) the design was consistent with international best practice for the sector; and (v) the project was designed flexibly and as a pilot (demonstration effect) that would improve the conditions for larger investments. This was achieved despite the very short time frame in which the project was prepared according to the wishes of the GoC.

The project represents a very quick but appropriate response (as a Learning phase) to a strongly felt need of Chile and other countries of the region. In addition to the recommendation of an International Conference of scientists, science administrators of neighboring countries, and the international community, the design of the project is based on consultations with the main stakeholders of the S&T sector, and discussions with Chile's foundation for technology development ("Fundación Chile"). The GoC also responded well by quickly putting the management system in place and obtaining the agreement of internationally well known scientists to serve on the MSI Program Committee. By the time the project became effective, in September 1999, the first selection cycle of projects was well underway and three Institutes and five Nuclei were selected and awarded grants within two months of effectiveness.

The Bank and counterpart teams have identified well the main sector issues, using, *inter alia*, substantial international comparative data from the region and else where in the world (see September 1998 project identification Aide Memoire). Throughout project preparation, the project teams identified well the major constraints facing Chilean scientists. These include: insufficient long term planning for and commitment to high quality scientific research, inadequate support to graduate students leading to understaffed laboratories, and scarcity of funds for equipment necessary for cutting edge research. Other constraints included excessively slow and bureaucratic funding procedures, fragmentation of resources, and unevenly applied funding criteria.

It was recognized from the outset that the time frame to effect substantive change in any S&T sector is in the order of 10 years or more. Hence, since the gains of MSI would depend on sustained effort and would not be expected to accrue in a linear fashion, the project rightly sought and obtained the Government's firm commitment to sustain support for the MSI for a period of 10 years as a part of its science policy. It was further recognized that prior to making a major investment in the sector, a pilot should be carried out to demonstrate ("proof of concept") that major changes in the performance of S&T systems could be leveraged with relatively modest investments implemented under international best practice procedures. Therefore, the LIL instrument was chosen and designated as the first phase of a two phase decade long investment program.

During preparation, the decision was made to locate the project implementation unit and the overall control of the project in the Ministry of Planning (MIDEPLAN) rather than in the National Committee for Science and Technology Research (*Comisión Nacional de Investigación Científica y Tecnológica* - CONICYT), the traditional government agency for science funding. This was done as a means to stimulate immediate changes and in order not make the success of the demonstration pilot contingent upon a long and involved process of institutional change within CONICYT. The decision was effective for the LIL. At the same time, institutional capacity has not directly been built in CONICYT by means of the project. Moreover, the decision led to an expansion of the mandate for MIDEPLAN, which had no previous mandate for or experience in science funding and administration. The government must now decide if the long term objectives of the MSI are better served by keeping it at MIDEPLAN and permanently expanding that Ministry's mandate, or transferring the MSI to CONICYT, or some combination of these alternatives.

4. Achievement of Objective and Outputs

4.1 Outcome/achievement of objective:

The project met its development objectives. It constituted a successful demonstration of an improved way of supporting scientific research in a cost effective manner and in ways that strengthened Chile's National Innovation System. The main outcomes of MSI are:

Science and technology is receiving increased attention by the GoC and other governments in the region. The MSI is having important effects in Chile and beyond. Chile's example has been followed by three other countries in Latin America that have established MSIs with the cooperation of the Bank, and several others have expressed an interest in developing their own MSI. Chile has taken the lead in initiating cooperation with these partner countries under the auspices of the MSI program.

The project has established a fair, open, and merit-based selection process which have been acknowledged and accepted by the scientific research community. In addition to assuring that the grants went to the most qualified researchers, the established process has influenced other scientific funding mechanisms in Chile, prompting them to conform more closely to international best practice.

The project has improved the productivity of Chile's top researchers. While it is still too early to completely assess the impact on researcher productivity (due to time lags inherent among performance of research, training, and publication of results), strong initial signals indicate that productivity and quality have increased due to the improved working conditions that MSI grants afforded to top researchers.

Opportunities for and the quality of advanced training have increased. A growing pool of young scientists, trained by well-recognized scientists and leaders in several disciplines is being created in Chile. This is an important first step in reaching the critical mass of qualified human capital required by a knowledge-based economy.

Several forms of collaboration increased significantly under the project's auspices. Greater synergy in joint work amongst scientists trained in different areas and different schools pursuing a common objective is becoming apparent in a relatively short time. Efforts of several centers to establish closer linkage between basic sciences and the strategic and applied sciences are visible, and linkages are being created amongst institutions and scientists at national, regional and international level involving both South-North and South-South cooperation. The independent, external reviewers of the project particularly noted the significance of these developments.

A monitoring and evaluation base is being built which can serve as a platform for improved S&T policy. The project has been thoroughly monitored and evaluated (M&E) by beneficiaries, the Bank, the Implementation and Management Unit (IMU), independent, external reviewers, and private consulting firms. M&E activities included substantial annual reports on all grants, consolidated reports by the Implementation Unit, and frequent Bank supervision. More importantly, M&E also involved two visits by panels of independent expert scientists (see reports of March 2000 and March 2001 in the project file), and the establishment of comprehensive baseline performance indicators for MSI and non-MSI researchers. This marks the first time that benchmarking for scientific productivity has been used in Chile, and will be an important ingredient in future S&T policy discussions.

Overall, the outcomes of the MSI have allowed Chile to increase its participation in generating and disseminating scientific knowledge.

4.2 Outputs by components:

Project Component 1 - Management Structure :

The outcome was the creation of a light and effective administrative structure for science funding. Administrative expenses amounted to only 5.5 percent of total project costs. This is significantly below the 10 percent originally planned. Administrative expenses comprised the project's Board of Directors and Program Committees including transport costs (air fares, per diems, etc.), salaries and the operational expenses for the Executive Secretariat (ES), plus the costs of the two independent external reviews. The percentage of administrative expenses to total project costs are within current levels for OECD countries, especially for funding programs in the initial phases of implementation.

In terms of management effectiveness, the project established a compact management structure that is fully operational. This structure includes the Board of Directors, chaired by the Minister of Planning, a Program Committee comprised of internationally-recognized scientists, and an Executive Secretariat staffed by competent and respected personnel. The successful planning and implementation of a transparent competitive funding mechanism is highly respected by scientists and is attracting a considerable number of applicants. According to most beneficiaries interviewed, the IMU maintains very close links with the Science Institutes and Nuclei established under the project and provides them with the necessary technical assistance and guidance in project implementation.

The ES, in cooperation with the Bank task team have conducted regular evaluations and monitoring of the institutions and nuclei funded under the program. A study on Baseline Data and Performance Indicators was recently completed and has been of great value to the IMU for the preparation of an impact evaluation of the research conducted over the past two years.

In cooperation with other branches of the Government, the IMU has initiated the dialogue for the follow on phase of the project. This on-going dialogue is progressing well.

Project Component 2 - Competitive Fund for Scientific Excellence:

Soon after project effectiveness, the first round of competitive funding was very efficiently completed. Three scientific institutes and five scientific nuclei (selected from amongst 75 applicants) were established and are operating for two years. The Science Institutes include: (i) The Millennium Institute for Advanced Studies in Cell Biology and Biotechnology; (ii) *Centro de Estudios Cientificos*; and (iii) Millennium Institute for Fundamental and Applied Biology. The Science Nuclei cover areas of (i) ecology and biodiversity; (ii) development biology and genetic engineering; (iii) cellular and molecular neuroscience; (iv) fine chemistry, and (v) condensed matter physics.

The LIL envisaged that the competitive grant financing process would be repeated immediately during calendar year 2000, permitting the unsuccessful applicants and others to improve their proposals and again seek funding. However, no call for proposals were issued during 2000 because of the several reasons. Basically, another round competitive fund selection (CFPs) involved additional commitment of government resources, which Congress did not wish to approve. In 2001 funds were made available and a second call for proposals was issued. The CFP selection process was expeditiously completed in 2001 and 5 additional nuclei were selected. The original physical targets for the Fund, comprising the establishment of 1-3 science institutes and 5-10 scientific nuclei, are fully met.

An expanded, high quality environment has been created for postgraduate training and research. Initial indications are that the number of publications in international journals will increase as a result of MSI research, although it is still too early to measure this impact. Over 150 key research workers including some of the best Chilean scientists, are directly funded under the Institutes and Nuclei grants. These include 66 graduate students (32 financed fully by the MSI and 34 partially funded) and 25 post-doctoral fellows. During project implementation, 47 PhD. diplomas were granted to the financed graduate students. An additional 252 graduate and undergraduate students funded from other sources, are associated with the MSI as researchers. This outcome makes the MSI Institutes and Nuclei by far the most productive source of advanced scientific training in Chile (see section 4.3).

Several outstanding international network and outreach activities have also taken place, including workshops, seminars, visiting professors, international symposia and training for secondary school teachers. These activities aimed at audience ranging from top international scientists, to students at the post-Doctoral, Doctoral, Masters, undergraduate, and secondary levels. (See Bi-annual Project Reports in the Project file).

Project Component 3 - Network for the Promotion of Scientific Excellence:

The main outputs of networking activities include: (i) Cooperation amongst MSI institutions for joint research programs and training programs; (ii) Dozens of international courses and advanced international seminars held; (iii) Participation of MSI scientists in regional and international networks; (iv) Students from neighboring countries admitted in research and training programs funded under MSI; and (v) Outreach programs including successful initiatives in some disciplines at secondary education level.

The MSI rules ensured that funds for networking and outreach were not fungible. All Institutes and Nuclei were required to conduct these activities, and no networking and outreach funds could by used for research purposes (e.g. purchase of additional equipment). Researchers credited this policy of non-fungibility with stimulating a significant increase in networking and especially outreach activities. Scientists felt that previously outreach had always been a second priority and an unfunded mandate. The MSI emphasis catalyzed numerous activities which the researchers reported to be highly worthwhile.

In addition, Chile has led the way in expanding regional cooperation under the auspices of the MSI, hosting the first meeting of representatives of the four Latin American countries that have MSI programs in collaboration with the Bank (Chile, Venezuela, Brazil, and Mexico). Colombia is considering to join the group.

4.3 Net Present Value/Economic rate of return:
Not applicable.

The LIL has been highly cost effective (see Annex 3). First, training opportunities for students have increased significantly. Eight percent of Chilean senior scientist and researchers are funded under the MSI (about 160 out of 2000) and are now responsible for training of close to 50 percent of the doctoral students in science and engineering. Half of these training opportunities are newly created with funds from the MSI grants. In addition, it is reasonable to expect, given the highly selective nature of the grants, that the students connected to MSI-funded research are receiving the highest quality training in Chile. These two factors combined have caused a jump in the efficiency of doctoral training in Chile.

Another source of improved cost-effectiveness is the light administrative structure that was piloted under the MSI. The cost of this structure (5.5 percent of total project cost) is in line with international good practice. It was also noted that the same administrative structure is capable of handling a much larger volume of grants without additional costs, so it is likely to become even more efficient as the project expands.

Finally, several sources of potential economic benefits were identified. These and others should be monitored so that, at a future date, formal cost-benefit analysis can be conducted. Most notable are the 6 patent applications have been filed by MSI grantees. These cover a range of industrial and commercial applications, including improvement of medical technologies (MRI processes for CAT scans), bioremediation for environmental pollution (bacteriological removal of heavy-metal contamination); and aquaculture (processes for characterizing viruses affecting commercially-cultivated salmon). These and other research outputs may provide direct economic benefits to Chile's economy in the future, beyond the direct cost-efficiency savings that are presently accruing.

4.4 Financial rate of return:
Not Applicable

4.5 Institutional development impact:
It is too early to assess the full impact of the project. However, there are positive indications that the LIL has created the desired pressures on scientists and managers to work as teams and perform their best, putting the limited resources to optimum use. If the project proceeds as planned to a second, longer and larger investment phase, this is likely to lead to a program of major reforms across the system.

However, it must be noted that the institutional capacity created by the project is within MIDEPLAN, as an alternative to the existing funding windows of CONICYT, Chile's traditional science funding agency. For the future, stakeholders report two issues that will be crucial to consolidating the institutional gains of the MSI. First, the MSI must maintain its independence as a program as this has proven a *sine qua non* condition of its success. Second, policies governing the MSI's relation to other science funding programs (such as the ability and desirability of researchers to hold simultaneous grants) should be rationalized and coordinated.

5. Major Factors Affecting Implementation and Outcome

5.1 Factors outside the control of government or implementing agency:
A risk that the MSI program would encounter difficulties due to internal tensions within the host institutions (universities and research centers where the grantees work) did not materialize. It was thought for instance, that some senior management at universities might not provide the necessary institutional collaboration to MSI grantees. However, the rigorous adherence of the ES to the transparent funding procedures helped create a situation in which institutions viewed hosting an MSI grantee as positive. Reviews by the independent

panel found that by the second year of the program, attitudes of resistance had largely changed to acceptance as hosting institutions came to view the existence of the MSI as a factor that could bring benefits.

Similarly, the risk that the MSI's focus on excellence would provoke resistance from the S&T community at large, or that it would be viewed as a unfair diversion of resources toward the elite and away from the average researcher has not materialized. There is, however, concern in the S&T community about similarities in the profile of grantees who compete for MSI and for grant under National Fund for Development of Priority Areas (*Fondo Nacional de Desarrollo de Areas Prioritarias* - FONDAP), CONICYT's highest level research grant program. There were situations in which grantees have won awards in both competitions and have had to renounce one of the grants. The ES is working with CONICYT to assure that no overlap occurs.

The reaction of the younger members of the Chilean S&T community to the MSI program has been overwhelmingly positive. The independent review panel noted the warm and enthusiastic response of students at all levels, as well as post-docs, to the opportunities that the MSI have afforded.

5.2 Factors generally subject to government control:

The government has given strong positive support to the MSI. The government has honored its commitments to provide counterpart funding and has exceeded those commitments by taking on multi-year contracts valued at additional 120 percent of the amount originally planned. All indications are that government will continue to meet these future obligations. The first round of awards committed over US$ 23 million to 3 institutes and five nuclei, exceeding the original plan by more than US$ 8 million. Although during 2000 the budget allocation from the government to the project was substantially lower than had been estimated, this occurred not only because the Chilean Congress reduced by 20 percent the amount of funds authorized for that year, but also because Parliament did not authorize the second call for proposals contemplated during year 2000. This budget reduction and delay had minor impact, as funds were made fully available the following year, and the five additional nuclei were contracted. The delay has not prevented the MSI from reaching its goals.

The government has not promoted the MSI sufficiently among potential private sector partners, as was the stated intention of the project. In fact, the MSI contains no mechanisms or incentives that specifically address the concerns and interests of the private sector in research. The second phase of investments in the MSI should devise specific incentives for authentic private sector collaboration.

5.3 Factors generally subject to implementing agency control:

The IMU has properly organized and conducted open competitions for grant awards following best practice at the international levels. However, the appropriate number of external written peer reviews of the proposals in these competitions was not reached by the program committee and not all proposals received a proper written evaluation.

The IMU conducted the second round of competition for nuclei in a timely manner in 2001, once the funds were authorized by the Parliament. Also, the IMU put substantial effort into informing Members of Congress and Ministry of Finance officials about to the nature and benefits of the MSI program, thereby minimizing potential delays or reductions in project funding.

The IMU assured the timely compliance of grantees with their obligations to provide written annual reports. This especially helped ensure the quality of the independent reviews, as the reviewers had these reports in advance of their site visits in Chile. This is indicative of the IMU's overall compliance in producing monitoring and evaluation data and reports required by the project.

The IMU has received praise from the Chilean scientific community for communicating rapidly and openly with all stakeholders. It established an informative website and immediately posted key documents, such as

the reports of the independent review panels. These actions helped consolidate the image of the program as transparent and built confidence more generally.

With respect to financial management, the Project Management Reporting (PMR) system was not functional within the agreed timeframe due to problems with the system and the consultancy. Substantial delays were encountered.

5.4 Costs and financing:

The total cost of LIL was estimated at US$15 million, including the IBRD loan of US$ 5 million and the Government counterpart funding of US$10 million. However, the LIL is part of a longer term program of investments and, given the multi-year nature of the research grants, the total obligations incurred with the 3 Institutes and 10 Nuclei ascend to US$ 27 million during the 2000-2004 period. At the original closing date of December 31, 2001 total loan disbursements amounted to US$4.6 million. To permit the full disbursement of the Loan, the Bank and the Government agreed to extend the Loan closing date to September 30, 2002, at which date the loan was fully disbursed. It is anticipated that the government will meet all existing obligations to MSI grantees in upcoming years. The Government has requested additional World Bank financing for the second phase of the MSI investment program.

6. Sustainability

6.1 Rationale for sustainability rating:

The Bank and the Borrower have agreed on transition arrangements for the project future operations which are reflected in the following performance indicators:

The MSI program was conceived from the outset as the forerunner of a decade-long investment program. The LIL was chosen for the first phase to provide the "proof of concept" that targeted investments in high quality science research could substantially improve the performance of the national S&T system.

The Government was already convinced during the preparation of the LIL that a follow on operation would be appropriate and necessary in order to reap the benefits of the initial investment. To this end, the Government has requested continued World Bank collaboration in the second phase of investments.

The Government has demonstrated its commitment to the project by (i) providing two-thirds of total project resources as counterpart funds and (ii) taking on additional obligations that exceed the its anticipated contribution to the LIL. The Government is committed to continuing and expanding the program to include major reforms in other areas of the S&T system.

The MSI program has supported excellence in highly selected institutions and scientists. These are now showing signs of delivering the expected medium term benefits. Consolidation of these benefits requires continued funding under the improved conditions that the MSI program has instituted.
The networking activities of the MSI have created new and strong linkages in the scientific community, facilitating collaboration and decreasing the isolation of Chile's researchers. The effects of these expanded linkages are likely to multiply in the future.

The high level of acceptance of the MSI and the enthusiasm of the S&T community with it, have made conditions favorable for more far reaching reforms and investment in the sector.

As the country that launched the MSI, Chile has taken a leadership role in the region to promote collaboration among regional colleagues that also have MSI programs (Venezuela, Brazil, and Mexico). The visibility and enthusiasm for these collaborations provide strong positive incentive for Chile to continue the MSI into its next phase.

There is a growing demand from students from other countries to come to Chile for their graduate work. This includes students from OECD countries (France, Germany, the United States) as well as neighboring countries (Peru, Argentina, Brazil, Uruguay).

6.2 Transition arrangement to regular operations:
The MSI is expected to move on to a second investment phase. See paragraph 6.1 above.

7. Bank and Borrower Performance

Bank
7.1 Lending:
The project was well prepared in a short time with extensive consultations and stakeholder discussions. The preparation was supported at the highest levels both in Chile and within the Bank. The result was a project that responded to the Government's felt need to increase investments in the elements of knowledge economy for the country.

7.2 Supervision:
The Supervision of the project has been excellent, using the best combination of Bank specialists and international experts. This is evident from, inter alia, the existence of two in-depth reviews by independent review panels conduct during the relatively short implementation period of project implementation.

Throughout project's implementation, the Bank has responded quickly and positively to requests from the Government, and has built close cooperation with government counterparts. In addition, supervision was time- and cost-effective because it was combined with supervision of another project in the higher education sector (the *Proyecto de Mejoramiento de la Calidad de la Educación Superior* - MECESUP).

Also, throughout implementation the Bank team kept a focus on the goal of systemic reforms, and capitalized on the success of the MSI for the S&T system as a whole. However, during supervision more attention could have been given to the collection of baseline data for monitoring and evaluation. As of March 2002 the indicator table shows excellent performance of the project. (See Annex 1).

The Bank team was instrumental in facilitated international cooperation and sharing of experiences with other countries in the region that have or are considering MSI programs (Brazil, Venezuela, Mexico, Colombia and Argentina).

7.3 Overall Bank performance:
Highly Satisfactory.

Borrower
7.4 Preparation:
The borrower had the highest level of political commitment to the project and conducted extensive consultations during project preparation. As a result, it was possible to prepare and begin implementation on a short time schedule.

7.5 Government implementation performance:
The Government has been highly supportive throughout implementation. Further, the government has demonstrated its commitment to support major reforms in the S&T system. Such a commitment is considered to be essential for any follow on phase of investment.

7.6 Implementing Agency:

The performance of the implementing agency (the IMU) has been highly satisfactory. The agency has facilitated two external independent reviews, in March 2000 and March 2001, using groups of excellent scientists who were quite demanding in their interviews, requests for evidence and documentation. The agency's effectiveness and cooperation with grantees has been repeatedly acknowledged by the review panels.

The IMU conducted the second round of competition for nuclei in a timely manner in 2001, once the funds were authorized by the Parliament. Also, the IMU put substantial effort into informing Members of Congress and Ministry of Finance officials as to the nature and benefits of the MSI program, thereby minimizing potential delays or reductions in project funding.

The IMU assured the timely compliance by grantees with their obligations to provide written annual reports. This was especially helpful to ensure the quality of the independent reviews, as the reviewers had these reports in advance of their site visits in Chile. This is indicative of the IMU's overall compliance in producing monitoring and evaluation data and reports that the project required.

Procurement was carried out at the level of the Institutes and Nuclei and the IMU assured that it was conducted according to Bank guidelines.

In order to maintain a system of complete transparency, the IMU developed a MSI-website in which all pertinent information was made available (see www.mideplan.cl\milenio).

7.7 Overall Borrower performance:
Highly Satisfactory.

8. Lessons Learned

Five major lessons learnt from this LIL are:

Demonstration of best practice for supporting the best. Even limited investment, distributed based on transparent and objective selection procedures, has a high impact on performance and productivity of an S&T system.

Effective use of investments. Autonomy in spending resources and diminished bureaucratic burdens improve the effectiveness of investment in advanced scientific research. However, it has been observed that access in Chile to state-of-the-art scientific equipment is not keeping up with growing demand.

Improved performance of the elite scientists. Chile has the conditions for catching-up in terms of human capital formation by rapidly expanding further training opportunities for the most advanced students. The quality of training can be improved with incremental investments that allow the best senior researchers to devote themselves full time to their professional responsibilities.

Cohesive Government performance is a key element to project success. Transparency in communication between Government players, the continuity in funding and the coherence of science, technology and innovation policy are of critical importance for the performance of the National Innovation System.

Favorable entry conditions contribute to successful project outcomes. Well defined roles of key stakeholders had a positive impact on the S&T system beyond direct cost-efficiency of the investment. For this benefit to be achieved, it is particularly important to ensure: (i) harmony between Government

priorities and sector policies and project design; (ii) involvement of beneficiaries in program design and implementation, and (iii) recognition and autonomy of research teams and scientific leadership.

9. Partner Comments

(a) Borrower/implementing agency:
Borrower / Implementing Agency

The following comments have been prepared by the MSI's Executive Secretariat (ES).

The Implementing Agency of the MSI Program agrees in general terms with all that has been written by the World Bank in this Implementation Completion Report, and it seems reasonable that the report be publicly available.

The report qualifies the Bank performance as "satisfactory" (S); the opinion of the ES is the following: in view of the high level of project management and the high technical and scientific quality of the economists and science advisors of the Bank, the institution's performance should be conceived as highly satisfactory (HS).

The MSI as a competitive fund for scientific research has developed several features seen for the first time in Chile: direct delivery of funds to researchers rather than to institutions; absence of defined priority areas of research to be funded; a Program Committee comprised entirely by distinguished foreign scientists; feasibility of formation of independent science institutes; compulsory development of activities for outreach and networking by Institutes and Nuclei; calls for proposals following a two stage procedure with preliminary and full proposals, and minimization of bureaucracy. Several of these properties have inspired other national competitive funds and have been considered by the MSI programs established in Mexico and Venezuela.

The MSI program appears highly coherent with the national policies in science and technology, at a stage when government decisions have been taken to increase the investment in the sector and to search for more efficient and productive modalities for the use of funds.

A significant number of proposals have applied in the bidding for projects (79 and 60 proposals in the 1999 and 2002 competitions, respectively) revealing a clear interest of the scientific community to be funded by the MSI program.

The selection process carried out by the Program Committee and resolved by the Board of Directors has been externally recognized to have awarded the best groups of scientists in Chile. Towards the end of the Learning and Innovation Loan, the 3 Institutes and 10 Nuclei comprise around 200 researchers including an important part of the best national scientists, 3 National Science Awards, 2 out of the 3 local members of the USA Academy of Sciences, the 3 national awardees in 2001 by the Howard Hughes Foundation and 15 past Science Presidential Chair scientists.

The external evaluations reveal important advances of Institutes and Nuclei particularly in the fields of research, formation of young scientists and network and outreach activities. Among these, three major world discoveries have been reported by three of the research centers so far, vis. The genome decoding of a harmful salmon bacteria – second in Latin America after Brazil; the development of physical instrumentation to validate medical scanner essays spoiled by patient's movements; and the first transgenic mice reared with gene modifications for advancement in teeth health and restoration.

Concerning patenting of discoveries and inventions, a field little developed in Chile, Institutes and Nuclei need to learn and proceed in registration of their innovations.

One of the centers (Institute for Advanced Studies in Cell Biology and Biotechnology, CBB) established a external international Board of Scientific Advisors. In view of the interesting and relevant recommendations raised by such committee, it appears useful to adopt the idea as a general policy for the Science Institutes.

The funds allocated with minor restrictions to Institutes and Nuclei have been properly used and the nature of the MSI program has been well appreciated by the awarded scientists. Two letters signed by the MSI scientists were sent to the Minister of MIDEPLAN and Chairman of the Board of Directors, highlighting the agile, flexible and modern means in which the program has been managed. An article describing the program's virtues was published in 2001 by Dr. M. Rosemblatt, deputy director of a Science Institute (available at www.mideplan.cl/milenio).

Further, the relevance of science and technology in the economic, social and cultural development of countries, associated with the implementation of the MSI program in Chile, was published by senator Gabriel Valdés through the Chilean Parliament (available at www.mideplan.cl/milenio).

The academic and research institutions, particularly universities, have been strengthened with the development of the MSI centers of excellence as part of them. Furthermore, to some extent the program has contributed to decentralization of national research and academic activities: 41% of the total funds have been allocated to groups outside the Metropolitan Region. Some regions have reacted positively to such stimuli providing centers with fresh financial resources and buildings.

Since its beginning, the MSI has established links with the *Programa de Mejoramiento de la Equidad y la Calidad de la Educación Superior* of the Ministry of Education, through exchange of documents, experiences and information on postgraduate students partially financed through the World Bank. With the *Comisión Nacional de Investigación Científica y Tecnológica* (CONICYT) close links have been established concerning information on scientists participating in the project proposals, the compatibility for involvement of researchers in different competitive funds and exchange of experiences between funding programs.

The participation of the private sector in national research and development and the connection between scientists and the industry in Chile are weak. A country's effort to change this situation is needed, with participation of the government, industry and the academic and scientific community, and it is believed that the MSI should play an important role through connections with the private sector, stimulating the insertion of scientists in the industry and fostering joint ventures.

The Board of Directors has met on two occasions per year, discussing and resolving key aspects of the program's performance. Among this, the Board has supported the government's decision to invite the World Bank to study a second phase for the continuation of the MSI program under a new loan agreement with the Bank. On the other hand, the Board has stressed its concern in that the MSI needs to have sufficient financial resources, and that the funds for the Science Institutes and Nuclei need to be secured and projected in a time horizon according to a defined plan.

(b) Cofinanciers:
Not Applicable

(c) Other partners (NGOs/private sector):
Not Applicable

10. Additional Information

Equity: The Millennium Science Initiative builds on the Chilean higher education system. Equity considerations follow directly from the underlying system. There are no specific inequities in Chile's advanced research system. However Chile's higher education system can further improved. There is still an uneven concentration of enrolment in the top income quintile (65 percent), while the two lowest quintiles merely reached 25.6 percent in year 2000. Gender equity has largely been achieved.

Enrolment per Type of Institution and Gender for year 2000

Institution	Men			Women	
	Enrolled 2000	Graduates	Degree Holders	Graduates	Degree Holders
U. del Consejo R.	138 267	6 872	10 907	6 205	10 443
U. Privadas	49 986	4 371	3 485	4 144	3 466
Institutos P.	38 076	3 244	2 719	2 524	3 247
Centros de F.T.	83 245	nd	nd	nd	n.d
Total	309 574	14 487	17 111	12 873	17 156

Annex 1. Key Performance Indicators/Log Frame Matrix

Area/ Theme	Indicator: Goal	Indicator: Actual	Variation from Goal	Data Source
Selection Process	Majority of surveyed scientists (winners and losers) rank MSI as fairest funding source	MSI confirmed as a credible and fair funding source	No substantial variation	Reports of Independent Expert Panels
Administrative Efficiency	Grant Processing time 50 percent faster than other research funding institutions	Grants processed within 60 days	None	IMU, grant recipients
Concentration of Resources for Research	Grants within 33 percent of OECD average for corresponding programs	Annual Grants average size of US$ 1.3 million (Institutes) and US$300,000 (Nuclei) consistent with OECD averages	None	IMU; Independent Expert Panel; Bank Supervision Visits.
Perception Regarding Stagnation of S&T Policy	Surveyed Scientists perceive positive change in working conditions and career possibilities	Scientist report improved working conditions and career possibilities. Repatriation of researchers apparently is increasing	Exceeded Original Goal	IMU; Independent Expert Panel; Bank Supervision Visits
Collaboration with International Scientists	20 percent increase in the number of collaborations, accompanied by improved duration and quality	At least 50 percent increase in collaborations; Reported duration and quality rising	2.5 times above original goal	Grantees Annual Reports: IMU data
Human Capital Training	50 percent increase in PhD's and Post-docs trained by MSI-funded researchers	50 percent increase in PhD's and Post-docs trained by MSI-funded researchers	Achieved	Grantees Annual Reports: IMU data
Promotion of Regional Network of Scientific Excellence	12 doctoral students or post-docs from neighboring countries trained under MSI fellowships	18 doctoral students or post-docs from neighboring countries trained under MSI fellowships	Exceeded Original Goal by 50%	

Annex 2. Project Costs and Financing

Project Cost by Component (in US$ million equivalent)

Component	Appraisal Estimate US$ million	Actual/Latest Estimate US$ million	Percentage of Appraisal
1. Management Structure for the Millennium Science Initiative	1.00	1.14	114
2. Competitive Fund for Scientific Excellence	12.00	12.49	104
3. Network for the promotion of Scientific Excellence	1.50	1.32	88
Total Baseline Cost	14.50	14.95	
Physical Contingencies	0.45		
Total Project Costs	14.95	14.95	
Front-end fee	0.05	0.05	1.00
Total Financing Required	15.00	15.00	

Project Financing by Component (in US$ million equivalent)

Component	Appraisal Estimate			Actual/Latest Estimate			Percentage of Appraisal		
	Bank	Govt.	CoF.	Bank	Govt.	CoF.	Bank	Govt.	CoF.
1. Management Structure for the Millennium Science Initiative	0.50	0.50		0.36	0.80		72.0	160.0	
2. Competitive Fund for Scientific Excellence	3.48	8.53		3.95	8.54		113.5	100.1	
3. Network for the promotion of Scientific Excellence	0.75	0.75		0.64	0.66		85.3	88.0	
Physical and Price Contigencies	0.23	0.23		0.00	0.00		0.0	0.0	
Front-end fee	0.05	0.00		0.05	0.00		100.0	0.0	
Total Financing Required	5.00	10.00		5.00	10.00		100.0	100.0	

Withdrawal of the Proceeds of the Loan

Category	Amount of the Loan Allocated (Expressed in Dollars)	% of Expenditures to be Financed
(1) Grants for Research Sub-projects	3,945,000	50% of the amounts disbursed under each Grant Agreement
(1A) Grants under part B of the project	460,000	
(2) Goods for Parts B and C of the Project	5,000	50%
(3) Consultants' services and training for Parts B and C of the Project	290,000	50%
(4) Operating Expenditures	250,000	50%
(5) Fee	50,000	Amount due under Section 2.04 of the Loan Agreement
TOTAL	5,000,000	

Annex 3. Economic Costs and Benefits

Economic analyses consistently show high social and economic rates of return to research and development (R&D) and innovation. Recent literature reviews have analyzed over 400 studies from industry (OECD, 2000) and agriculture (Pardey and Beintema, 2001). The vast majority of studies found positive, high rates of return on investments. However, R&D is not fundamental research and the benefits of fundamental research are more difficult to measure. The most common methodologies usually measure either (i) the impact of publications and citations resulting from the research or (ii) the economic value of outputs of research, in terms of production function analysis or social rates of return. However, the best available methodologies are often unable to completely measure the outputs from fundamental research (Popper, 1995) which may include:

Training new scientific and technical workers;
Enriched expertise and experience of current researchers;
Development of "schools" of researchers who represent an informal community focused on a particular system;
Exploration of new experimental designs, instrumentation, and research protocols;
Increased numbers of "guesses" about the nature of the system being explored;
Lowering the notional price of an "option" on a prospective technological application which may or may not have some value in the future and for which the basic research finding provides an input;
Negative results which are important in more effectively directing subsequent efforts which may then lead to positive results; and
Intangible benefits conferred on society and the public imagination by the search itself, and/or its contribution to a culture of science that will facilitate future discoveries.

Some of these outputs are not amenable to empirical testing, or are only amenable to certain forms of qualitative assessments. In addition, time frames for the appearance of output from fundamental research are idiosyncratic and non-linear. Important findings from fundamental research have remained unused for decades until being "discovered" by happenstance. Even when results are utilized immediately after publication, time horizons for the development of applications can run 10 years or more.

For these reasons, and consistent with the guidelines for LILs, no formal rate of return analysis was undertaken for the project. Instead, categories were identified which could serve as indicators of the cost-effectiveness of research. In addition, research outputs were to be monitored for their future potential to provide economic returns.

With respect to cost-effectiveness, the project appears to have catalyzed significant savings. First, training opportunities for students have increased significantly. Best estimates are that they have doubled. The small percentage of Chilean senior scientist and researchers who are funded under the MSI represent fewer than 8 percent of all researchers in Chile (about 160 out of 2000), but they are responsible for training close to 50 percent of the doctoral students in science and engineering. Half of these training opportunities are newly created with funds from the MSI grants. In addition, it is reasonable to expect, given the highly selective nature of the grants, that the students connected to MSI-funded research are receiving the highest quality training in Chile. These two factors combined have caused a jump in the efficiency of doctoral training in Chile.

Another source of improved cost-effectiveness is the light administrative structure that was piloted under the MSI. The cost of this structure (5.5 percent of total project cost) was found to be in line with international good practice. It was also noted that the same administrative structure is capable of handling a much larger volume of grants without additional costs, so it is likely to become even more efficient as the project expands.

Finally, several sources of potential economic benefits were identified. These and others should be monitored so that, at a future date, formal cost-benefit analysis can be conducted. Most notable are the 6 patent applications that have been filed by MSI grantees. These cover a range of industrial and commercial applications, including improvement of medical technologies (MRI processes for CAT scans), bioremediation for environmental pollution (bacteriological removal of heavy-metal contamination); and aquaculture (processes for characterizing viruses affecting commercially-cultivated salmon). These and other research outputs may provide direct economic benefits to Chile's economy in the future, beyond the cost-efficiency saving that are presently accruing.

Annex 4. Bank Inputs

(a) Missions:

Stage of Project Cycle	Month/Year	No. of Persons and Specialty (e.g. 2 Economists, 1 FMS, etc.) Count	Specialty	Performance Rating: Implementation Progress	Performance Rating: Development Objective
Identification/Preparation					
	Nov/1998	*4*	Team Leader, 1 S&T Policy Specialist, 1 S&T Management Specialist, 1 Consultant		
Appraisal/Negotiation					
	Jan/1999	*7*	Team Leader, 1S&T Policy Specialist, 1 S&T Management Specialist, 1Procurement Specialist, 3 Consultants		
	March/1999	*6*	Team Leader, 1S&T Policy Specialist, 1 S&T Management Specialist, 1Procurement Specialist, 1FMS, 1 Lawyer		
Supervision					
	August/1999	*5*	Team Leader, 1 S&T Management Specialist, 1 Consultant, 1Procurement Specialist, 1FMS,	S	S
	March-April/2000	*4*	Team leader, 1 S&T Management Specialist, S&T Specialist-consultant, 1Procurement Specialist, 1FMS,	S	S
	Aug-Sept/2000	*3*	Team Leader, S&T Specialist- Consultatnt, 1 FMS	S	S
	Jan/ 2001	*3*	Team Leader, 1 Education Economist, 1 Procurement Specialist	S	HS
	July/2001	*4*	Team Leader, S&T Specialist- consultant, 1 Procurement Specialist, 1 S&T Management Specialist-consultant	HS	HS
ICR					
	March/2002	*7*	Team Leader, 1 Education Specialist, 1 S&T Specialist, 1 S&T Policy Specialist, 1 Procurement Specialist, 1 FMS, 1 Consultant	HS	HS

(b) Staff:

Stage of Project Cycle	Actual/Latest Estimate	
	No. Staff weeks	US$ ('000)
Identification/Preparation	10	32.00
Appraisal/Negotiation	22	70.32
Supervision	46	139.32
ICR	16	61.4
Total	94	243.04

Annex 5. Ratings for Achievement of Objectives/Outputs of Components

(H=High, SU=Substantial, M=Modest, N=Negligible, NA=Not Applicable)

	Rating
Macro policies	*M*
Sector Policies	*H*
Physical	*SU*
Financial	*SU*
Institutional Development	*H*
Environmental	*NA*
Social Poverty Reduction	*NA*
Gender	*M*
Other (Please specify)	*SU*
Team building	*NA*
	SU
	NA

Annex 6. Ratings of Bank and Borrower Performance

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HU=Highly Unsatisfactory)

6.1 Bank performance	*Rating*
Lending	*HS*
Supervision	*S*
Overall	*HS*

6.2 Borrower performance	*Rating*
Preparation	*HS*
Government implementation performance	*S*
Implementation agency performance	*HS*
Overall	*HS*

Annex 7. List of Supporting Documents

Banda, E., Brennan, M., Crasemann, B., "Mid-term external evaluation mission in Chile, March 2000" April 2000.

Banda, E., Cody, M., Luxoro, M. Onuchic, J., Oro, L., "External evaluation of the MSI Program" (2001).

INVERTECT IGT "Performance Indicator Report" (2001).

INVPROJECT (Argentina) "Project Management Report" (1999-2001).

MSI Implementation Management Unit "Bi annual Report (1999/2000)" (2000).

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OECD "Science, Technology, and Industry Outlook 2000" OECD, Paris, 2001.

Pardey, P. G., and Beintema, N.M., "Slow Magic: Agricultural R&D a Century After Mendel" IFPRI Food Policy Report, International Food Policy Research Institute, Washington, October 2001.

Popper, S. W., "Economic Approaches to Measuring the Performance and Benefits of Fundamental Science" RAND, Critical Technologies Institute, Washington, 1995.

Rosemblatt, M., "El primer cumpleaños de la Iniciativa Científica Milenio" Revista Bioplanet, Año 2, Nº 10 - Marzo/Abril 2001, p. 24-25.

Valdés, G., "La ciencia en Chile y el Programa Milenio" República de Chile, Diario de Sesiones del Senado, Legislatura 343ª extraordinaria, Sesión 5ª, 17 de Octubre de 2000.

Additional Annex 8. Status of Legal Covenants

	Covenant Class	Covenant Status	Original Fulfill Date	Revised Fulfill Date	Description of Covenant
2.03	10	Partially complied with	03/31/2002	9/30/2002	Closing Date for the Project
3.01 (b)	2	Partially complied with	09/23/1999	7/2/2001	Operation of the Competitive Fund
3.03 (a)	5	Complied with			Project overall oversight
3.04 (b)	10	Complied with	06/30/2000		Monitoring and evaluation of the Project
3.04 (c) (ii)	10	Complied with	06/30/2000		Selection procedures of Beneficiaries
3.05	10	Complied with	09/23/1999		Adoption of the Operational Manual to the satisfaction of the Bank
3.06	10	Complied with	09/30/2002	3/31/2003	Plan for future operations of the Project
4.01 (b) (ii)	1	Complied with	05/15/2000		Financial Audit of the Project
4.02 (b)	1	Complied with	05/15/2000		Presentation of Project Management Report
4.03	1	Complied with			Audit of Procurement of Goods, Works and Services
5.01	10	Complied with	09/23/1999		Effectiveness conditions for the Loan